

REMARKS

The present application includes claims 1-20. Claims 1-20 were rejected by the Examiner. In response, claims 1, 4, 5, 9 and 15 have been amended to include further limitations, and claims 2 and 10 have been cancelled.

Claims 1-10 and 12-14 were rejected under 35 U.S.C. 103(a) as being unpatentable over Graumann et al. (U.S. Patent No. 6,382,835), Watanabe (U.S. Patent No. 6,325,537), Navab et al. (U.S. Patent No. 6,236,704), Fujii et al. (U.S. Patent No. 6,606,826), Berestov (U.S. Patent Application No. 2003/0113006), and in further view of Grover et al. (U.S. Patent No. 5,200,700). Claim 11 was rejected under 35 U.S.C. 103(a) as being unpatentable over Graumann, Watanabe, Navab, Fujii, Berestov and Grover and further in view of Umebayashi (Japanese Patent No. 58190702 A). Claims 15, 16, 19 and 20 were rejected under 35 U.S.C. 103(a) as being unpatentable over Graumann, Fujii, Berestov and further in view of Glover. Claims 17 and 18 were rejected under 35 U.S.C. 103(a) as being unpatentable over Graumann, Fujii, Berestov and Grover and further in view of Umebayashi (Japanese Patent No. 58190702 A).

The amended independent claims each include limitations requiring the method or system having a step or feature for dynamically tracking the position of a detector and/or a source during imaging using a tracking system having a transmitter and a sensor. The amended claims further include the limitation that the normalization of the magnification change is based upon the tracked position of the detector and/or the source. Support for the amendment is found throughout the specification of the Present Application,

including, but not limited to paragraphs [0026-0027], [0030], [0035-0036] as well as the original dependent claims 2 and 10, which are now cancelled due to their incorporation into the independent claims 1 and 9, respectively.

The amended claims of the present application recite the use of a tracking system having a transmitter and a sensor. The transmitter and sensor accurately provide the position of the source, detector and/or object to the tracking system, thus allowing the positions to be dynamically determined throughout the imaging process. In other words, each image taken during the imaging process will have a corresponding position of the source, detector and/or object. The ability to track the actual positions alleviates the need to estimate or calculate the positions using geometries and algorithms. The tracked positions allow for the formation of a virtual isocenter of the imaging system, and provide a way to maintain the object at the virtual isocenter. The tracked positions are then used as a basis to normalize the magnification change for the images, thereby providing compensation for distortion and irregularity of the projection images during reconstruction.

The references cited by the examiner do not discuss use of a tracking system having a transmitter and a sensor. Nor do any of the references discuss dynamic tracking of the position of the imaging equipment (source or detector) or the object. Neither do the references recite formation of a virtual isocenter as the term is defined by the present application. Finally, the cited references do not suggest using the tracked position of the detector and/or source to normalize the magnification change of the image data.

Accordingly, for at least these reasons, the references cited by the Examiner do not render unpatentable the claims of the Present Application as they presently read.

Graumann relates to an X-ray apparatus having a carrier and a motor for rotating the carrier around a horizontal axis to obtain a series of 2D X-ray projections that are used to produce a 3D image. Graumann discusses using a non-isocentrically adjustable C-arm to obtain X-ray images. See, e.g., Graumann Col 2, Lines 29-30. Graumann does not discuss dynamic tracking of the position of the source and/or the detector using a tracking system having a transmitter and sensor. Accordingly, because Graumann does not dynamically track the position of the source and/or the detector, Graumann does not teach forming and maintaining an object at a virtual isocenter throughout the imaging process. Nor does Graumann teach using the tracked position of the sensor and/or the detector to normalize the magnification change in image data.

Graumann discusses calibration of the imaging system using a phantom so that the projection angles and geometries can be determined for a series of 2D projections to determine the positions of the detector and/or source relative to the imaged object. See, e.g., Graumann Col 5, Lines 1-5 (“these projection geometries are determined in a calibration event preceding the registration of the series of 2D projections of a subset, and are stored in a memory 17 for the later production of a respective 3D image dataset from the registered series of 2D projections respectively for different subjects.”). The calibration event is a time consuming step requiring additional equipment and involving complex calculations that can give rise to measurement and calculation errors and uncertainties. Implementation of the tracking system alleviates all of these issues by

providing accurate positions of source and/or detector for each image taken during the imaging process. See, e.g., Para [0026] of the Present Application.

The tracking system having a transmitter and a sensor tells the imaging system a tracked position of the components at every instant as opposed to a calculated or estimated position. The tracking system allows for a true determination of the respective locations of the source, detector and/or object during imaging. See, e.g., Para [0027] of the Present Application. The knowledge of the true positions allows the system to normalize the magnification change for each image taken based on the positional relationships between the source, the detector and/or the object, and the images may be reconstructed accordingly. See, e.g., Para [0030] of the Present Application. Neither Graumann, the other cited references, nor the combination of Graumann with any of the cited references suggest a method or system for processing images that requires all the limitations of the amended claims of the Present Application.

Furthermore, none of the references cited by the Examiner disclose the formation of a virtual isocenter, and/or maintaining the object at the virtual isocenter throughout imaging as recited by the limitations of the independent claims of the Present Application. The virtual isocenter is formed by determining a distance between an object and a source and/or detector. As the source and detector orbit around the object, the positional relationships between the object and the source and/or detector change as stated by the limitations of the pending claims. Those positions are dynamically determined using the tracking system. Because the motion of the source and/or the detector is non-isocentric, the object does not remain at the actual center of the imaging

system. By dynamically tracking the positions of the source and/or detector with respect to the object, however, the method and/or system establishes and maintains maintain the object at a virtual isocenter.

The Examiner cites Watanabe for teaching a method comprising varying a distance between an object and at least one of a detector and a source to form a virtual isocenter. Watanabe relates to an X-ray diagnosis apparatus having a C-shaped arm, an X-ray detector and an X-ray generator such that the position and direction of the X-ray detector and the X-ray generator is freely changeable. See, e.g., Watanabe Abstract. More specifically, Watanabe teaches an apparatus wherein the X-ray detector, the X-ray generator, and a bed upon which an object is placed change position or direction during a scan to control the positional relationship such that the object remains the center of the scan. See, e.g., Watanabe Col. 2, Lines 17-18, 55-59, Col. 6, Lines 13-21. Thus, the position of the source and/or detector of Watanabe does not vary with respect to the position of the object during imaging. The object of Watanabe remains at the actual isometric center of the imaging scan. Watanabe does not, therefore, teach forming a virtual isocenter.

The specification of the present application states that a virtual isocenter is formed by changing the detector to object distance, and results in a magnification change in the resulting image. See, e.g., Para. [0024] of the Present Application. Since Watanabe teaches positioning the X-ray generator, X-ray detector and the bed upon which an object is placed such that the positions between the detector and the object are kept constant, thereby keeping the imaging magnification ratio constant, Watanabe does not teach

forming a virtual isocenter. See, e.g., Watanabe Col 3, Lines 55-64. Accordingly the combination of Watanabe and Graumann does not teach all of the limitations of the amended claims of the present application, specifically the limitations involving a virtual isocenter.

The Examiner also states that Navab teaches a method comprising a step of varying distance between an object and at least one of a detector and a source to form a virtual isocenter. Navab discusses compensation for motion of a detector relative to an X-ray source by warping the image on the detector plane to a virtual detector plane and then mapping the image into three-dimensional space. See, e.g., Abstract. Navab uses a marker plate having a geometry that acts as a calibration tool. See, e.g., Navab Col 2, Lines 6-8. Navab does not teach determining the positions of source and/or the detector, nor does it suggest dynamically tracking the positions. The method used to determine the distance between the detector and the source of Navab uses a marker plate as a calibration tool, similar to the calibration event discussed in Graumann. See, e.g., Navab Col 2, Lines 3-8 (“When X-ray energy issues from the source 100, it passes through the marker plate 112 and the image of the markers 114 is projected onto the detector, providing an indication of the special relationship and orientation between the object 130 and the image on the detector plane 142.”). Thus, Navab does not teach formation of a virtual isocenter based on positions of the source and/or detectors as recited in the claims, and defined in the specification of the Present Application.

The Examiner cites Fujii as disclosing the method step wherein a C-arm is moved in a vertical and horizontal direction, and setting a distance between a subject and an X-

ray focus point, and a distance between an object and an X-ray image reception device. Fujii does not, however, disclose forming a virtual isocenter. Nor does Fujii suggest tracking, or dynamically tracking the positions of a source and/or a detector.

The Examiner cites Berestov as teaching a method comprising the step of normalizing a magnification change in image data obtained as said virtual isocenter is maintained. The Applicant disagrees that Berestov maintains a virtual isocenter. Berestov uses system geometry to determine positions of imaging equipment. See, e.g., Berestov Para [0032] (geometry recovery module 46.). Berestov does not apply dynamic tracking using a tracking system having a sensor and transmitter. Accordingly, Berestov cannot form or maintain an object at a virtual isocenter.

The Examiner cites Glover as teaching a method comprising the step of normalizing a magnification change in image data obtained as said virtual isocenter is maintained, and maintaining an object at said virtual isocenter during imaging of said object. Glover does not teach using a tracking system and thus does not teach normalizing a magnification change in image data based upon the tracked position of at least one of said detector and said source, as read by the limitations of the currently amended claims. Furthermore, since Glover does not use a tracking system, Glover does not teach forming and maintaining an object at a virtual isocenter. Glover discusses processing locations of motion data in the system using geometry models and calculations. See, e.g., Glover Col 8, Lines 25-50. As discussed, without dynamically tracking the position of the source and/or detector using a tracking system, Glover cannot form a virtual isocenter.

Finally, the Examiner cites Umebayashi as teaching an apparatus wherein a tracking system comprises an electromagnetic tracking system. Umebayashi merely discusses comparing two sensing units to calculate the distance between them. See, e.g., Abstract, Umebayashi. The tracking system of Umebayashi thus only determines a distance between two sensors, and does not discuss tracking a position of a source and/or detector as required by the limitations of the pending claims of the Present Application. Tracking the positions of the source and/or detector in space with respect to the position of the imaged object are significant, as projection angles and other relationships affect the image reconstruction. Umebayashi also fails to discuss dynamic tracking, thereby failing to make possible the formation of a virtual isocenter possible, the maintaining of an imaged object at the virtual isocenter and the normalization of the magnification change based on the tracked position of the sensor and/or the source, even when combined with any of the other cited references.

Accordingly, each of the cited references fail to disclose several limitations of the independent claims of the Present Application as currently amended. Accordingly, even if it were obvious to one of ordinary skill in the art to combine one or more of the cited references, which the Applicant asserts that it is not, the combined references would still not teach all the limitations as necessary to render the claims unpatentable. For at least these reasons, the Applicant respectfully submits that independent claims 1, 9, and 15 should be allowable over the cited art of record. Since currently pending dependent claims 3-8, 11-14, and 16-20 depend from allowable claims 1, 9, and 15, respectively, the

Applicant submits that claims 3-8, 11-14, and 16-20 should also be allowable over the cited art of record.

With regard to the Examiner's response to Applicant's arguments made on January 17, 2008 in response to the Office Action mailed October 31, 2007, the Applicant maintains that the claims of the present application are allowable over the cited references for the reasons provided in that response.

Finally, the Applicant submits that the pending claims are allowable over the art cited by the Examiner but not relied upon in his rejections (Earl et al. U.S. Patent No. 6,456,383, Nakamura, U.S. Patent No. 5,930,328, Boutenko et al. U.S. Patent No. 7,194,065, Senzig, U.S. Patent No. 7,016,457 and Webber et al., U.S. Patent No. 6,810,278). None of these references disclose using a tracking system having a sensor and a transmitter; dynamically tracking the position of the source and/or detector; the formation of a virtual isocenter; maintaining an object at the virtual isocenter during imaging; or normalization of magnification changes in image data based on the tracked position of the source and/or detector. Accordingly, the above cited references do not render the claims of the Present Application unpatentable.

CONCLUSION

The Applicants submit that the present application is in condition for allowance.

If the Examiner has any questions or the Applicants can be of any assistance, the Examiner is invited and encouraged to contact the Applicants at the number below.

The Commissioner is authorized to charge any additional fees or credit overpayment to the Deposit Account of GTC, Account No. 070845.

Respectfully submitted,

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